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Citation for published version (APA):

Freedman, D., Lyness, E., Lee, G., Nixon, I., Beddoes, P., & Srivastava, V. (2016). Can we predict Acute Medical readmissions using the BOOST tool? *C P D Journal. Acute Medicine*, 15(3), 119-123.
<http://acutemedjournal.co.uk/research-audit-and-clinical-practice/can-we-predict-acute-medical-readmissions-using-the-boost-tool-a-retrospective-case-note-review/>

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Title page: Can we predict Acute Medical readmissions using the BOOST tool?

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Abstract

Background: Readmissions within 30-days of hospital discharge are a problem. The aim was to determine if the **Better Outcomes for Older Adults through Safe Transitions (BOOST)** risk assessment tool was applicable within the UK.

Methods: Patients over 65 readmitted were identified retrospectively. BOOST assessment was applied with 1 point for each risk factor.

Results: 324 patients were readmitted (mean age 77 years) with a median of 7 days between discharge and readmission. The median BOOST score was 3 (IQR 2-4) with polypharmacy evident in 88% and prior hospitalisation in 70%. The tool correctly predicted 90% of readmissions using two or more risk factors and 99.1% if one risk factor included.

Conclusion: The BOOST assessment tool appears appropriate in predicting readmissions.

Keywords: Readmission, audit, hospital discharge, predictive tool

Key points:

- There is a growing trend of emergency admissions and readmissions to hospital and the problem is likely to continue to grow due to an ageing population that has complex medical needs.
- Different tools and processes have been developed in an attempt to reduce hospital readmission including PARR 30 and SQLape.
- One recent predictive programme proposed is the BOOST project tool (Better Outcomes by Optimizing Safe Transitions) that was developed by the Society of Hospital Medicine.
- A total of 324 patients aged over 65 years were readmitted with median age of 77 (SD ± 8.4 years).

- Examining the BOOST risk factors, by far the most commonly recorded variable was polypharmacy with 88% of patients recorded as having 5 or more medications.
- The tool correctly predicted 90% of readmissions using two or more risk factors, rising to 99.1% if at least 1 risk factor was included.
- BOOST has the potential to be routinely used and play a role in identifying high-risk patients on admission and reducing 30-day re-admission rates for general medical patients.

Introduction

There is a growing trend of emergency admissions and readmissions to hospital in the United Kingdom (UK) and other countries.¹⁻³ The rates of readmission vary greatly with a recent systematic review across 34 studies identifying a median of 27% of avoidable readmissions with a range of 5 to 79%.⁴ The problem is endemic to most high-income countries with figures demonstrating 30 and 90 day readmission rates of 20% and 34% respectively.⁵ Within the UK National Health Service (NHS), there is an average readmission rate of 15-30% and these are almost always as an emergency. A five year review in England revealed a 30-day readmissions rate of 7% and of these, 30% were deemed as avoidable admissions with an associated annual cost of £1.6 billion.² Financial penalties are applied by the clinical commissioners who do not pay the hospital for readmissions within 30 days of discharge. With the fiscal limitations already in place on hospitals, reducing hospital length of stay is emerging as an important target in hospitals. The main reasons for readmission are adverse events relating to the illness or presenting complaint but in many instances the reason for readmission relates to inadequate care co-ordination within the community setting.⁵

The problem is likely to continue to grow due to an ageing population that has complex medical needs. A recent paper reviewed 30-day readmissions in 82 million NHS hospital records from 2004 to 2010 and categorised the reasons for readmissions based on International Classification of Diseases (ICD) codes. Seven percent of discharges required readmission within 30 days, 30% of which were categorised as potentially preventable and 20% as anticipated but unpredictable readmissions. A further 30% of readmissions broadly related to previous admission. This exploratory categorisation highlighted the need for better hospital readmission strategies with distinctive categories of readmission risk identified. However, discharging patients from hospital back to their home or the community can be a complex process and one meta-analysis reported that less than one in four readmissions were deemed avoidable.⁴ With an ageing population who often have multiple long-term conditions, it is not always possible to avoid readmission.⁶⁻⁸

Different tools and processes have been developed in an attempt to reduce hospital readmission including PARR 30 and SQLape 9 (Billings et al., 2012). The PARR 30 used an algorithm to predict readmission within 30 days and reported a positive predictive value of 59.2% with the area under the receiver operating characteristic curve was 0.70 (95% CI: 0.69-0.70). The model had low sensitivity and the authors commented that further work was needed to validate the model. Donze et al. (2013) used a computerized algorithm that was based on administrative data (SQLape) and of the 2398 readmissions, 879 (8.5% of all discharges) were deemed avoidable (10). The 7 independent factors identified were haemoglobin and sodium level at discharge, discharge from oncology service, procedure during index admission, index type of admission, the number of admissions in previous 12 months and length of stay. The tool had a discriminatory power of 0.71 and the authors concluded that this tool may be able to identify patients who need intensive transitional care interventions. However Kansagara et al. (2013) in a systematic review of risk prediction models for hospital readmission concede that despite the numerous predictive tools perform poorly and there is a need to improve their performance. ¹¹

One recent predictive programme proposed is the BOOST project tool (Better Outcomes by Optimizing Safe Transitions) that was developed by the Society of Hospital Medicine (12). The main objectives of the BOOST project were: (i) Identify high-risk patients on admission and target risk-specific interventions, (ii) reduce 30-day readmission rates for general medicine patients, (iii) reduce length of stay (iv) improve facility patient satisfaction and (v) improve information flow between in-patient and out-patient providers (www.hospitalmedicine.org/ResourceRoom)(13). Subsequently the toolkit was revised and 180 hospitals participated in BOOST implementation.

The aim of this study was to pilot the BOOST risk assessment tool to patients aged more than 65 years discharged within the UK healthcare system.

Methods

Setting

A large hospital in south London was the setting. Approximately 11,000 patients are admitted every year to the Acute Medical Unit (AMU). The AMU is a 58 bedded unit. Patients are usually admitted through the emergency department and a small number are referred directly by General Practitioners (GP) or other hospitals or ambulatory care facilities.

A list of all medical readmissions in 2014 was identified from the hospital admissions database. The case notes of patients over the age of 65 years admitted to the Acute Medical Unit (AMU) were reviewed. A team of physicians (DF, EL, PB, IN) reviewed the casenotes to identify risk factors listed in the BOOST tool.

The BOOST assessment tool was used. A total of 8 variables were recorded using binary method (i.e. 0=no, 1=yes). The total score that can be recorded is 8 with the higher scores reflecting greater number of risk factors. The eight variables recorded were:

- Problem Medication: including medication such as anticoagulation, insulin, aspirin and clopidogrel dual therapy, metered dose inhalers
- Prior Hospitalisation: number of non-elective hospitalisations in the previous 6 months
- Psychological: Depression diagnosed or documented in the medical history
- Principal Diagnosis: Heart failure, COPD, Diabetes, Stroke
- Polypharmacy: 5 or more medications (this has since been revised to 10 medications)
- Poor health literacy
- Patient support: does the patient have a willing and able family member or friend or is there an absence of caregiver to assist with discharge and home care?
- Palliative Care: Does the patient have an advanced or progressive serious illness? Would you be surprised if patient died this year?

Ethics approval was not required as this was deemed a service evaluation.

Data were entered into SPSS v 21 and descriptive statistics performed. Means, median and standard deviations were calculated for continuous data and the median and Inter-quartile range (IQR) used for the BOOST scores. Cross tabulation was undertaken to compare those who died during readmission and those discharged home. A p value of 0.05 was deemed significant.

Results

A total of 324 patients aged over 65 years were readmitted with median age of 77 (SD ± 8.4 years). There was a median of 9.4 days between discharge and readmission and the median BOOST score was 3 (IQR 2-4) (**Table 1**).

Table 1: Demographic data of readmitted patients (n=324)

Descriptive data	Mean (SD)
Age (years, SD)	77.4 (± 8.4) Median: 78 years
Average number of days to readmission	9.4 (± 8) Median: 7 days
BOOST predictive score (median, IQR)	3 (2-4)

Examining the BOOST risk factors, by far the most commonly recorded variable was polypharmacy with 88% of patients recorded as having 5 or more medications. Seventy percent of patients had been hospitalised for non-elective reasons in the previous 6 months (see **Table 2**). Reason for readmission was not related to principal diagnosis of conditions such as cancer, CVD, diabetes, COPD, stroke and heart failure in 49% of cases.

Table 2: Number of BOOST variables in readmitted patients (n=324)

BOOST Variable	Number (%)
Problem Medication	158 (48.8%)
Prior Hospitalisation	227 (70.1%)
Psychological	67 (20.7%)
Principal Diagnosis	164 (50.6%)
Polypharmacy	285 (88.0%)
Poor health literacy	38 (11.7%)
Patient support	9 (2.8%)
Palliative Care	130 (40.1%)

Examining the number of BOOST risk factors, over 50% of patients had 3 or 4 risk factors (**Table 3**). The IQR for risk factors was 2 to 4 variables and these account for 71.6% of all readmissions. Very few patients had 6 or 7 BOOST risk factors (n=14, 4.3%).

Table 3: Number of predictors per patient

BOOST Variable	Number of patient (n, %)
0 risk factors	3 (0.9%)
1 BOOST risk factor	25 (7.7%)
2 BOOST risk factors	62 (19.1%)
3 BOOST risk factors	87 (26.9%)
4 BOOST risk factors	83 (25.6%)
5 BOOST risk factors	50 (15.4%)
6 BOOST risk factors	12 (3.7%)
7 BOOST risk factors	2 (0.6%)

A total of 29 patients died on readmission and in terms of differences between those who died and those who were discharged. There was a significant difference in age with those who died older than those who were discharged (died vs. survived: 80.5 ± 10 vs. 77.1 ± 8 years, $p=0.033$). Days to readmission was significantly longer in those who died on readmission compared to those who were discharged (14 ± 9 days vs. 9 ± 8 days, $p=.001$). Examining the BOOST variables in those who died, there was significant differences between those who died and those who were discharged in terms of problem medication ($\chi^2 = 5.2$, $p=.031$), principal diagnosis ($\chi^2 = 19.1$, $p<.01$) and palliative care ($\chi^2 = 23.7$, $p<.0.01$).

Examining those who were readmitted to the MAC unit, no differences were noted in terms of age or number of days to readmission. The only difference between MAC readmission and other readmissions with BOOST variables was palliative care ($\chi^2 = 6.05$, $p=.016$).

Discussion

From this retrospective analysis of data on 324 patients who were readmitted, the tool correctly predicted 90% of readmissions using two or more risk factors, rising to 99.1% if at least 1 risk factor was included. The median BOOST score was 3 (IQR 2-4). Polypharmacy (>5 medications) was evident in 88% and prior hospitalisation was evident in 70% of patients. Approximately half of readmitted patients were prescribed problem medication (like anticoagulants and insulin).

Reason for readmission was not related to principal diagnosis of conditions such as cancer, diabetes, COPD, stroke and heart failure in 49% of cases. A total of 40% had palliative care needs and 20% had mental health diagnoses. Only 2.8% of readmissions were associated with level of patient support and 11% with health literacy. These data highlight the complex healthcare needs of these readmitted older patients with high levels of polypharmacy and prior hospitalisation. The PARR 30 also used similar variables in their model (admissions in previous year for example) and included the Charlson comorbidity index and index of multiple deprivation.⁹ The PARR 30 model had limited

predictive ability and others have conceded the issues attempting to predict who would be admitted within 30 days.¹⁴

There was a median of 7 days (mean 9.4, SD \pm 8 days) between discharge and readmission. This translates to patients being at home for 7 days before being readmitted. This suggests that targeted interventions applied in the first week after discharge could potentially reduce readmission rates. The interventions would be determined by the risk factors identified by the BOOST tool. Others have highlighted the importance of adequate discharge planning and organising interventions that need to be initiated during hospitalisation.¹⁵⁻¹⁷ A recent study by Blunt et al (2015) suggested that 30% of all readmissions were preventable and identified six potentially preventable causes.¹⁸ There is also evidence to suggest that hospital volume is associated with differing readmission rates.¹⁹ In their study of 4651 acute care hospitals in the US, the authors reported that mean 30-day readmission rates varied according to hospital volume, with the fifth of hospitals with lowest volume associated with 14.7 readmissions (SD \pm 5.3), compared to 15.9 readmissions (SD \pm 1.7) among the fifth of hospitals with the highest volume ($p < 0.001$). Although interestingly, there was no difference in mean 30-day standardized mortality between the highest and lowest volume fifths (20.4 vs. 20.2, $p = 0.19$). The conclusion is that readmissions are associated with different aspects of care other than mortality or complications. Given that nearly 50% of cases in our retrospective study were readmitted for reasons not related to their principal diagnoses, suggest that indeed there are other reasons for readmissions and this needs further examination. One of the issues in the UK is organising community based care and with austerity, there are limited services available. A King's fund report also acknowledged the level of complexity in organising community based services and the lack of rapid responses for patients being discharged from acute hospital settings.²⁰ There is a lack of homogeneity in community based care with some areas providing excellent services whilst others are less than optimal.²¹

With the average NHS readmission rate of 15-30% of emergency admissions and admissions within 30 days of discharge not paid by the clinical commissioners, it is imperative that mechanisms are put in place that help reduce readmissions. The next stage will be to apply the BOOST tool prospectively to determine if it can accurately predict readmissions in UK patients and then to determine if hospital interventions using the BOOST tools can reduce the readmission rates. The BOOST tool also includes a discharge checklist that needs to be completed prior to discharge and includes medications reconciled with pre-admission list, Teach Back with patient and/or caregiver and documented receipt for out-patient follow-up with the primary care provider. The literature clearly demonstrates the importance of planning and optimising discharge plans and the BOOST tool allows all documentation to be collected on one sheet.

Identifying high-risk patients on admission has the ability to address the risk factor during hospitalisation and working in tandem with community based services to ensure a successful hospital to home transition to reduce the need for re-admission. A “hospital at home” service is now available for patients being discharged from King’s College Hospital (KCH). The purpose of this team is to prevent avoidable hospital admissions and facilitate early discharge by providing high intensity short-term interventions for acute episodes of illness in a person’s home. The team is multidisciplinary, consisting of nurses, doctors, physiotherapists, pharmacist and occupational therapists. The service provides daily visits in a person’s home up to 4 times a day for 3-7 days offering intensive nursing, physiotherapy, occupational therapy as required. Further analysis is needed to determine if this service has had an impact on reducing readmission rates and this will be undertaken shortly.

There is now evidence that clinical issues such as cognitive impairment can predict poor outcomes and increase the risk of re-admission. The BOOST project have incorporated the Rankin Disability Score that records a graded scale from 0 to 5 (no significant disability to severe disability) along with age, self-rated walking limitation and prior living status (i.e. living alone). These variables are

assessed and represent an Early Screen for Discharge Planning. Undoubtedly prudent planning has the ability to recognise what services need to be organised prior to discharge and also ensure discharge is not delayed.

Data from a pilot in six hospitals who implemented BOOST revealed barriers including inadequate understanding of current discharge process, insufficient administrative support and lack of resources.²²

Limitations

There are some limitations that need to be considered. The patients' medical histories were reviewed retrospectively and therefore relied on documentation to assess the various variables.

There is the issue of missing data or inaccurate or missing documentation. However, where there was a note regarding depression in the medical notes for example, the medication chart was accessed to check for relevant medication to support the diagnosis. The data collectors were all clinicians working within the medical unit and therefore familiar with the record keeping practices of the hospital.

A second potential limitation is the poor documentation on health literacy. Since the BOOST project tool records this information prospectively based on the "Teach Back tool", we were unable to capture it robustly in this study.²³ This information is also not routinely recorded in the UK and there is a possibility that health literacy may have been underestimated by us. A prospective study would address this and also include data on Teach Back education sessions which have been shown to improve health literacy and medication adherence.

Undertaking a prospective study using BOOST may also help us demonstrate the quality of care provided and compare those who were not readmitted to those who were readmitted and determine BOOST tool's discriminatory power in a UK population. The US literature on BOOST has

demonstrated improved patient satisfaction as well as improved flow of information between the hospital and community healthcare services/providers. This gap in the delivery of care has often been cited as a contributor to access block and readmission rates.

Conclusion:

The BOOST assessment tool appears appropriate for use in predicting readmissions within the UK setting. BOOST has the potential to be routinely used and play a role in identifying high-risk patients on admission and reducing 30-day re-admission rates for general medical patients.

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